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Phenomenological modeling of thrombus formation: an application for aortic dissection

Alireza Jafarinia[1], Chlöe Harriet Armour[2], Xiao Yun Xu[2], Thomas Hochrainer[1]

[1] Institute of Strength of Materials, Graz University of Technology, Kopernikusgasse 24/I, 8010 Graz, Austria
[2] Department of Chemical Engineering, Imperial College London, London SW7 2AZ, UK
alireza.jafarinia@tugraz.at, chloe.armour13@imperial.ac.uk, yun.xu@imperial.ac.uk, hochrainer@tugraz.at

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Aortic dissection (AD) is a disease with a high mortality rate. AD is triggered by the occurrence of a tear in the aortic wall. Then, the blood flow pushes through the tear between the aortic wall layers and generates a new blood passageway, the so-called false lumen (FL). AD is categorized as type B when the aortic wall rupture occurs in the descending thoracic aorta (Stanford Classification System). As a result of hemodynamic conditions in the FL, blood coagulation might occur, leading to FL thrombosis. The status of FL thrombosis in the FL affects the patients' chances of survival, where a complete thrombosis is usually beneficial. Thrombus formation is a complicated phenomenon including many biological and chemical processes, and it is unclear why thrombosis may occur during AD. In Type B AD, the FL thrombosis is mainly governed by the local hemodynamic conditions, enhanced in low shear rate zones in the FL [1].

In the current study, we have developed a novel computational method for predicting FL thrombosis based on purely hemodynamic conditions in the FL. This model is developed based on the findings of [1-3]. The model only controls the thrombus growth by local shear rate and shear stress in the FL. We implemented the model to a patient-specific type B dissection. The predicted status of FL thrombosis is in excellent agreement with the follow-up scans of the patient. The high computational efficiency of the model equips us with a tool to assist clinicians in the prognosis and decision-making process.

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